

Remarks/Arguments

Applicants respectfully request favorable reconsideration of the subject application, particularly in view of the above amendment and the following remarks. There is no additional fee for this amendment as the number of independent claims remains unchanged and the total number of claims has been reduced.

Before proceeding further, Applicants wish to thank the Examiner for his comments clarifying the bases for rejection of the subject application during the course of a telephone interview with the undersigned. His comments were very helpful in putting together this amendment in response to the pending Office Action.

Applicants have amended Claim 1 of the subject application so as to clarify the structure of the carbonaceous material reactor vessel which is a component of the claimed invention. Specifically, Claim 1 has been amended to provide that the reactor vessel comprises at least one wall which encloses a reaction space, that the reaction space contains a reaction zone containing a carbonaceous material, that the reaction space contains a product gas zone containing a reaction product gas, that the at least one wall forms a carbonaceous material inlet, an hydrogen-rich gas outlet, and a retentate gas outlet, and that the reaction space contains at least one permeable hydrogen-selective membrane. This amendment is fully supported, for example, by Claim 1 of the application as originally filed as well as by Fig. 4 of the application.

Fig. 4 shows a carbonaceous material reactor vessel 11 having at least one wall which encloses a reaction space containing a reaction zone 14 and a product gas zone 15. Also disposed within the reaction space is a permeable hydrogen-selective membrane 16, one side 17 of which contacts a reaction product gas and the other side 18 of which contacts a hydrogen-rich gas. The at least one wall forms a carbonaceous material inlet 12, an hydrogen-rich gas outlet 19, and a retentate gas outlet 13. Accordingly, Applicants respectfully urge that this amendment incorporates no impermissible new subject matter into the application.

Claim 2 of the subject application has been amended to provide that the carbonaceous material is a solid material. This amendment is supported, for example, in paragraph [0001] of the specification of the application which describes carbonaceous materials as including coal, biomass, and petroleum coke, all of which are solid materials. Accordingly, Applicants respectfully urge that this amendment incorporates no impermissible new subject matter into the application.

Claim 8 has been amended to provide that the at least one permeable hydrogen-selective membrane is disposed within a membrane module disposed within the reaction space. This amendment is supported by Fig. 7 of the application which shows a membrane module 75 disposed within the reaction space of a reactor vessel

71. Accordingly, Applicants respectfully urge that this amendment incorporates no impermissible new subject matter into the application.

Finally, Claims 5 and 17 have been canceled.

The invention claimed by Applicants is an apparatus comprising a carbonaceous material reactor vessel comprising at least one wall which encloses a reaction space. Disposed within the reaction space are a reaction zone containing a carbonaceous material and a product gas zone containing a reaction product gas. The at least one wall forms a carbonaceous material inlet, an hydrogen-rich gas outlet, and a retentate gas outlet. Disposed within the reaction space is at least one permeable hydrogen-selective membrane having a first side in contact with the reaction product gas and an opposite second side in contact with an hydrogen-rich gas. *The essential feature of this invention is the disposition of a membrane selective for hydrogen permeation in the reaction space of the reactor vessel in which a carbonaceous material is converted to a reaction product gas (typically a synthesis gas) comprising hydrogen, as a result of which the generated hydrogen is able to be immediately separated from the other components comprising the reaction product gas.* Applicants respectfully urge that the prior art relied upon by the Examiner for rejection of the subject application neither teaches nor suggests an apparatus as claimed by Applicants

comprising a membrane selective for hydrogen permeation disposed inside the reaction space formed by the walls of a carbonaceous material reactor vessel.

Claims 1-12 and 14-23 have been rejected under 35 U.S.C. 102(b) as being anticipated by Wachsman et al., U.S. Patent 6,296,687 (hereinafter "the Wachsman et al. patent"). This rejection is respectfully traversed. The Wachsman et al. patent teaches a mixed protonic-electronic conducting material for use as a hydrogen permeation membrane or electrode material (Col. 1, lines 8-10). Fig. 1 shows conceptually how H₂ permeation takes place according to the invention. Specifically, Fig. 1 shows a membrane reactor 10 in which the wall 11 may be either a H₂ permeation membrane 12 or an electrode 13. Natural gas or synthesis gas is fed through the reactor 10. The natural gas is converted to H₂ and C₂₊, with *in situ* H₂ separation by way of the electrode 13 or H₂ is separated from the syn gas by means of the H₂ permeation membrane 12 (Col. 4, lines 3-13). Applicants respectfully urge that the Wachsman et al. patent neither teaches nor suggests a carbonaceous material reactor vessel having at least one wall enclosing a reaction space and forming a carbonaceous material inlet, an hydrogen-rich gas outlet, and a retentate gas outlet as required by Applicants' claimed invention. In addition, because H₂ permeation membrane 12 of the Wachsman et al. patent corresponds to the wall 11 of the membrane reactor 10, Applicants respectfully urge that the Wachsman et al. patent

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does not show a permeable hydrogen-selective membrane disposed *within* the reaction space formed by the walls of a carbonaceous material reactor vessel as required by Applicants' claimed invention. Accordingly, Applicants respectfully urge that the Wachsman et al. patent does not anticipate the invention claimed by Applicants in the manner required by 35 U.S.C. 102(b).

Claims 9 and 21 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Wachsman et al. patent. This rejection is respectfully traversed. Applicants' arguments with respect to the Wachsman et al. patent as set forth herein above are equally applicable to this rejection. That is, Applicants respectfully urge that the Wachsman et al. patent neither teaches nor suggests a permeable hydrogen-selective membrane disposed *within* the reaction space formed by the walls of a carbonaceous material reactor vessel as required by Applicants' claimed invention. Accordingly, changing the shape of the permeable hydrogen-selective membrane of the Wachsman et al. patent in accordance with Applicants' claimed invention would not result in the invention claimed by Applicants. Thus, Applicants respectfully urge that the Wachsman et al. patent does not render Applicants' claimed invention obvious in the manner required by 35 U.S.C. 103(a).

Claim 13 has been rejected under 35 U.S.C. 103(a) as being unpatentable over the Wachsman et al. patent in view of Keskar et al., U.S. Patent

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6,066,307 (hereinafter “the Keskar et al. patent”). This rejection is respectfully traversed. The Keskar et al. patent teaches a method of producing hydrogen using a solid electrolyte membrane in which a compressed and heated oxygen-containing gas mixture is passed into a reactor having at least one solid electrolyte oxygen ion transport membrane to separate transported oxygen, in which reactor an organic fuel reacts with oxygen separated from the oxygen-containing gas to form synthesis gas. The resulting synthesis gas is separated into hydrogen gas through at least one solid electrolyte hydrogen transport membrane to separate the transported hydrogen in the same or different separator (Abstract). Citing Col. 2, lines 19-30, the Keskar et al. patent is relied upon by the Examiner as teaching that it is favorable to utilize a fluidized bed as a gasification reactor with a membrane reformer, based upon which the Examiner argues that it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the apparatus of the Wachsman et al. patent with the teachings of the Keskar et al. patent to utilize a fluidized bed as such modification would result in improved rates of reaction for the production of gasification products.

Applicants’ arguments with respect to the Wachsman et al. patent as set forth herein above are equally applicable to this rejection and, thus, will not be repeated other than to reiterate that the Wachsman et al. patent neither teaches nor

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suggests disposition of a permeable hydrogen-selective membrane within the reaction space formed by the wall(s) of a carbonaceous material reactor vessel as required by Applicants' claimed invention.

Col. 2, lines 19-21 of the Keskar et al. patent states

“To improve the rates of reactions and selectivity of certain products, an *external* catalyst in the form of a fixed or fluidized bed, or a plurality of catalyst tubes, may be used.” (emphasis added)

Applicants respectfully urge that the passage of the Keskar et al. patent cited by the Examiner does not teach the use of a fluidized bed as a *gasification reactor* with a membrane reformer. That is, it is well-known to those skilled in the art that the uses of fixed and fluidized beds extend far beyond gasification reactors and processes. For example, fluidized bed reactors are still used to produce gasoline and other fuels, along with many other chemicals. Many industrially produced polymers are made using fluidized bed reactor technology, such as rubber, vinyl chloride, polyethylene, and styrenes. Applicants respectfully urge that the passage cited by the Examiner merely teaches that it is known to use an external catalyst in the form of a fixed or fluidized bed to promote the reactions of partial oxidation and/or steam reforming of hydrocarbon feedstocks. Nowhere does the Keskar et al. patent teach or suggest the use of fixed or fluidized beds in connection with gasification. In addition, because the Wachsman et al. patent does not teach or suggest disposition of a permeable

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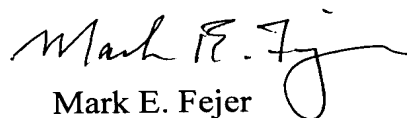
hydrogen-selective membrane within the reaction space formed by the wall(s) of a carbonaceous material reactor vessel as required by Applicants' claimed invention, Applicants respectfully urge that the combination of the teachings of the Wachsman et al. patent and the Keskar et al. patent would not result in the invention claimed by Applicants, i.e. disposition of a permeable hydrogen-selective membrane within the reaction space of, i.e. inside, a fluidized bed gasification reactor as claimed by Applicants. Accordingly, Applicants respectfully urge that the Wachsman et al. patent and the Keskar et al. patent, alone or in combination, do not render Applicants' claimed invention obvious in the manner required by 35 U.S.C. 103(a).

Conclusion

Applicants intend to be fully responsive to the outstanding Office Action. If the Examiner detects any issue which the Examiner believes Applicants have not addressed in this response, Applicants urge the Examiner to contact the undersigned.

Applicants sincerely believe that this patent application is now in condition for allowance and, thus, respectfully request early allowance.

Respectfully submitted,


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